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Notes on Mexican Herpetofauna 31: Are Roads in Nuevo León, Mexico, Taking Their Toll on Snake Populations? (Part II)

David Lazcano [1], Daryne B. Esquivel Arévalo [1], Arturo I. Heredia Villarreal [1], Juan Antonio García Salas [2], Bryan Navarro-Velázquez [1] and Manuel Nevárez-de los Reyes [1]

Abstract

Mortality caused by vehicular road traffic is among the principal contributors to decreased gene pools in amphibian and reptile populations. This phenomenon has been documented to some extent for other areas of Mexico by recent authors, but for the northeast of the country our herpetological group at the Universidad Autónoma de Nuevo Leon has been documenting the finding of snake road kills. This has become a topic of interest at many universities in Mexico. To document this anthropogenic phenomenon, we examined the herpetological collection catalogue of UANL/FCB for DOR (Dead on Road) specimens found on various state roads during the period 2008–2016. Seventy-nine specimens, representing five families, 20 genera and 31 species, were recorded from 10 classified roads.

Keywords: Road kills (DOR); snakes; Nuevo León, Mexico

Resumen

Mortalidad causada por el tráfico vehicular esta entre la causa o contribuir en la disminución del patrimonio genético en las poblaciones de anfibios y reptiles cercanas a estas. Este fenómeno se ha documentado escasamente en algunas zonas de México por cierto autores, pero para el noreste del país nuestro grupo herpetológico aquí en el Universidad Autónoma de Nuevo León ha estado documentando el hallazgo de serpientes en carreteras federales, estatales o municipales (área urbana). Sin embargo recientemente este fenómeno a despertados un gran interés en muchas universidades en México, en buen ahora. Para documentar este fenómeno antropogénico, examinamos el catálogo de la colección herpetológica preservada de UANL/FCB para documenta las muestras de animales atropellados en los diferentes caminos del estado durante el período (2008–2016), resultaron un total de 79 ejemplares con la representación de 5 familias, 20 géneros y 31 especies, que fueron localizadas en 10 caminos que clasificados.

Palabras Claves: Atropelladas; serpientes; Nuevo León, México

Introduction

It would be impossible to cite all the many articles out there dealing with the effects that roads have on vertebrate populations, and this literature continues to grow. Amphibians and reptiles that transit roads during their terrestrial movements while carrying out their physiological needs on a daily or seasonal basis are especially vulnerable, and sustain high mortality rate (Langton, 1989; Ashley and Robinson, 1996; Smith and Dodd, 2003; Aresco, 2005; Hamer et al., 2015; Andrews et al., 2015). Death as a result of road traffic plays an important role in the mortality rates of reptiles (Sullivan, 2012; Sullivan et al., 2016). Trombulak and Frissell (1999) reviewed the ecological effects of roads on animal populations. Factors that may affect mortality in various organisms include the speed with which they cross roads, body length (Hels and Buchwald, 2001; Gibbs and Shriver, 2002), movement patterns (Jaeger et al., 2005), traffic intensity and speed (Forman et al., 2003), and changes in habitat associated with road construction (Rudolf et al., 1999; Kjoss and Litvaitis, 2001).

A very particular factor attracting ectotherms to roads is the need to thermoregulate (Forman et al., 2003; Andrews et al., 2015). It has been hypothesized that reptiles and amphibians are attracted to roads to elevate their body temperature on cool nights following sunny days because the road surface remains warmer than the air and surrounding landscape (Dodd et al., 1989; Rosen and Lowe, 1994). The heat stored on the road surface is released into the atmosphere at night, creating "heat islands." Animals respond to these heat islands: snakes, for example, preferentially aggregate on or near warm roads, increasing their risk of being hit by cars (Trombulak and Frissell, 1999). In the northeastern United States and southeastern Canada, road mortality is associated with population declines and altered population structure of amphibians and reptiles (Fahrig et al., 1995; Marchand and Litvaitis, 2004; Steen and Gibbs, 2004; Gibbs and Shriver, 2005). Habitat fragmentation and physical barriers imposed by roads pose what many conservation ecologists consider the greatest obstruction to maintaining species diversity and ecological integrity in areas that are being urbanized or altered for human transportation activities (Wilcox

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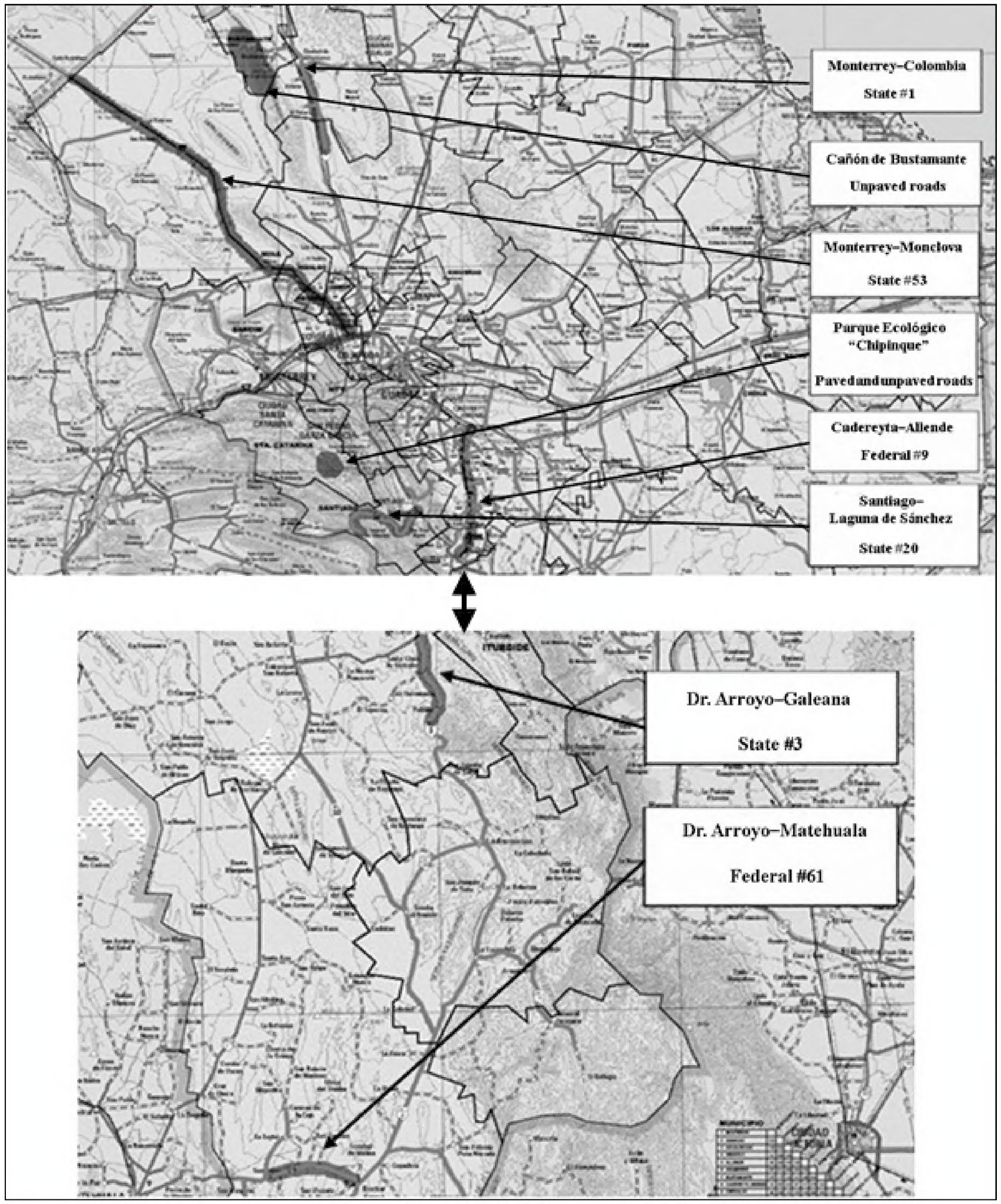


Figure 1. Locations of roads in the Mexican state of Nuevo León from which road-killed snakes were taken for this study.

and Murphy, 1985; Saunders and Hobbs, 1991; Forman and Alexander, 1998). In general, mortality increases with traffic volume (Rosen and Lowe, 1994; Fahrig et al., 1995).

It has been documented that reptile and amphibian species, and even sex and age classes within species, differ as to the cause of movements that result in road crossing (Gibbs, 1998; Semlitsch, 2000; Carr and Fahrig, 2001; Andrews and Gibbons, 2005; Steen and Smith, 2006).

Roads have been shown to result in the sudden population decrease of several species (Beaudry et al., 2008, 2010; Corlatti et al., 2009). They form physical barriers, limiting or preventing regular movements in now isolated populations and potentially increase the probability of local extinction (Benítez-López et al., 2010; van der Ree et al., 2015). Such barriers may alter the genetic diversity of the separated populations (Steen and Gibbs, 2004; Clark et al., 2010).

Environmental scientists have studied how to minimize these effects by constructing fences or elevated sections of the road or underground passages (Yanes et al., 1995). Also signs can be used to reduce the velocity of vehicles in areas where animals frequently cross (Arroyave et al., 2006; Barrí, 2010). The effectiveness of such methods varies greatly between taxa (Bissonette and Adair, 2008; Glista et al., 2009; van der Ree et al., 2015).

There has been an increasing interest in documenting the effect of roads on mortality of vertebrate fauna in Mexico (Grosselet et al., 2009; Herrera-Robledo, 2011; Martínez-

Hernández, 2011). Even a magnificent animals like tapirs (*Tapirus bairdi*), a threatened species with restricted distribution in the Peninsula of Yucatan and south of Veracruz, have been found road-killed (Puc-Sánchez et al., 2013). But the effects of road-kill have been documented in the northeast of Mexico only by Lazcano et al. (2009). With increasing traffic volume and road construction (federal, state, municipal and dirt roads) throughout Nuevo León, it is without doubt a rising problem for reptiles and amphibians, especially for those federal or state roads that for kilometers may have a mid-road traffic barrier. Such roads make it even more difficult for living creatures to cross; here we find not just herpetofauna, but also mammals such as field rodents, coyotes, deer, opossums, ring-tails, armadillos, and thousands of invertebrates, trapped and killed. Mortality is also frequently observed on roads close to cities, where many domestic animals are found DOR. Terrible traffic accidents occur when horses are allowed to roam without any restraint within city limits, a never-ending problem because horses are still used as draft animals throughout the Metropolitan Area of Monterrey.

Study Area

The state of Nuevo León lies between 98°17′ and 101°07′W, and between 23°06′ and 27°50′N. Neighboring states are Tamaulipas to the east, Texas on the northeastern border, Coahuila to the northwest and west, and Zacatecas and San Luis Potosí to the southwest. Shaped as an irregular rhombus exceeding 500 km at its longest (north/south) axis, its area is 64,081.94 km^2. Nuevo León is the 13th largest state in Mexico and the 14th most densely-populated, at 73 people per km^2 (wikipedia.org; accessed 16 September 2016). Most of the state falls within the Northern Temperate Zone. However, a small portion extends south of the Tropic of Cancer (Cantú-Ayala et al., 2013).

Table 1 lists the roads in Nuevo León where we found DORs. The state connects directly to all important destinations of Mexico via federal roads, and to all its 51 municipalities via state roads. Here we assigned a name and number only to the roads that had DORs registered.

Nuevo León encompasses a transition zone between the Nearctic and Neotropical biogeographic divisions, giving the state a variety of ecosystems that have an enormous influence on the distributional patterns of vertebrate groups (Cantú-Ayala et al., 2013). Some of the following vegetation types are present: gypsophyllous plants, piedmont, rosetophilous scrub, chaparral, and oak and pine-oak forests (Cantú-Ayala et al., 2013). These vegetation assemblages play an extremely important role in species distribution..

Federally protected areas account for 4.3% of the state's territory. These are the following three national parks: Cumbres in the municipalities of Allende, Monterrey, Santa Catarina, San Pedro Garza García, and Santiago (177,395 ha); El Sabinal in the municipality of Cerralvo (8 ha); and Monumento Natural Cerro de la Silla in the municipalities of Guadalupe, Juarez and Monterrey (6,039 ha) (Arriaga et al., 2000; Nevárez-de los Reyes et al., 2016).

Nuevo León now has 29 state (191,926.1 ha) and three federal (183,449 ha) protected areas, a total of 375,375.1 ha (Nevárez-de los Reyes et al., 2016), with an additional five in review. We presume that these protected areas help lower the pressure on state wildlife populations, but we consider this to be insufficient, due to the fact that the state has an extremely large population (SEDESOL et al., 2007), growing both from within and because of people coming in from neighboring states. Plus, these protected areas have many dirt roads crossing through them, and here we can also occasionally find DORs. Without a doubt, the consistent, unplanned urban development represents a direct threat to the state's ecosystems.

Materials and Methods

Methods that can be used when working on DOR herpetofauna have been documented by Langen et al. (2007). We reviewed the UANL electronic catalogue from the years 2008–2016, looking for any DOR specimens registered. We extracted from these DOR specimens the following information: species identification, date collected, SVL, tail length, total length, sex, DOR condition, locality, municipality, and the road on which they were found. These are the only parameters taken; microhabitat was not recorded. We created two tables and a figure to summarize this information. To designate the roads where specimens where found during this study, we numbered them from 1 to 10 in Table 1 (see also Figure 1). We included in Table 1 the official road number from the state map and the number of specimens found. Traffic volumes were not included because the data were not available for the particular sections of roads where we found road kills. The road numbers from Table 1 were then used in Table 2, which summarizes the species that were found as DORs, giving the average SVL of each species found, the roads on which it was found and the conservation status (Mexican Nom. and IUCN). Figure 1 summarizes the number of specimens found by year and season. Unfortunately, no specific survey method was followed; our data accumulated as a result of specimens found during our trips to different areas of the state when we were conducting herpetological surveys or from occasional visits to the areas for landscape photography.

Table 1. Roads where specimens were found and number of specimens.

Assigned road number	Official road number	Number of specimens found
1. Streets in urban area	none	6
2. Chipinque Ecological Park (dirt roads / tracks)	none	6
3. Chipinque Ecological Park (paved road)	none	10
4. Dr. Arroyo–Galeana	State #3	23
5. Laguna de Sánchez	State #20	17
6. Cañón de Bustamante	State # 94	3
7. Monterrey–Colombia	State # 1	6
8. Cadereyta–Allende	Federal #9	5
9. Monterrey–Monclova	State #53	2
10. Dr. Arroyo–Matehuala	Federal #61	1

Table 2. Species found in the categorized roads. **NOM** = protection status under NOM-ECOL-059-2010 (SEMARNAT, 2010): Pr = Protección Especial (Special Protection); A = Amenazada (Threatened). **IUCN** = protection status according to the International Union for Conservation of Nature: LC = least concern; EN = endangered.

Family	Species	Number found	Average SVL (mm)	Road numbers where found	NOM	IUCN
Colubridae	*Arizona elegans arenicola*	2	418	4, 7	–	LC
	Bogertophis subocularis	1	584	6	–	LC
	Coluber constrictor oaxaca	3	627	2, 5, 5	A	LC
	Coluber flagellum testaceus	3	934	1, 4, 4	A	LC
	Coluber schotti ruthveni	4	404	4, 3, 7, 7	–	LC
	Drymarchon melanurus erebennus	1	498	3	–	LC
	Gyalopion canum	1	223	4	–	LC
	Lampropeltis alterna	2	521.5	5, 6	A	LC
	Lampropeltis annulata	2	450	8, 8	–	–
	Lampropeltis mexicana	1	373	8	A	LC
	Lampropeltis splendida	2	519.5	4, 4	–	–
	Leptophis mexicanus	1	404	5	A	LC
	Pantherophis bairdi	4	765	2, 5, 2, 5	–	LC
	Pantherophis emoryi	3	840	9, 1, 3	–	LC
	Pituophis catenifer sayi	2	721	7, 7	–	LC
	Pituophis deppei jani	5	755.2	4, 4, 4, 4, 5	A	LC
	Rhinocheilus lecontei tessellatus	5	441	4, 4, 4, 9, 7	–	LC
Dipsadidae	*Diadophis punctatus*	1	338	5	–	LC
	Hypsiglena jani texana	5	280.5	4, 4, 4, 4, 1	–	–
	Leptodeira septentrionalis	5	551.7	5, 3, 1, 6, 1	–	–
	Rhadinaea montana	4	153	5, 4, 5, 2	Pr	EN
	Tropidodipsas sartorii	7	322.2	5, 3, 3, 3, 5, 3, 2	Pr	LC
Natricidae	*Storeria dekayi texana*	1	187	3	–	LC
	Thamnophis cyrtopsis cyrtopsis	2	271	4, 5	–	LC
	Thamnophis marcianus marcianus	1	219	8	A	LC
	Thamnophis proximus diabolicus	1	?	5	A	LC
Elapidae	*Micrurus tener*	3	376	8, 1, 3	–	LC
Viperidae	*Crotalus atrox*	2	537	4, 2	Pr	LC
	Crotalus molossus nigrescens	3	507.5	4, 5, 4	Pr	LC
	Crotalus scutulatus scutulatus	1	370	10	Pr	LC
	Crotalus totonacus	1	?	5	–	–
Anguidae	*Gerrhonotus infernalis*	50	125	3, 3	–	LC

Results

We found the largest number of snakes on Road 4 (Dr. Arroyo–Galeana), with 23 specimens representing 29.11% of the total specimens found in data analyzed. During this period of time (2008-2016), we obtained data from 79 specimens in five families, 20 genera, and 31 species (Table 2). Our largest snake specimen was *Coluber flagellum testaceus* with a SVL of 934 mm. and our smallest was *Rhadinaea montana* with a SVL of 153 mm. Road 3 is in the Parque Ecológico Chipinque. This is a very popular place for people of the Monterrey Metropolitan Area to visit, for outdoor sports or just for relaxation. There is a paved road that runs for about 7 km from the park entrance up to what is known as "La Meseta." Here we found eight of the 31 species of DORs listed in Table 2, including *Gerrhonotus infernalis* (Texas Alligator Lizard / *Falso Escorpión*). We decided to include this lizard in Table 2 because it represents the most common species found as DOR, more than 50 individuals in the last 10 years (Lazcano et al., 2006). We found seven specimens of *Tropidodipsas sartorii* (Sartori's Snail Sucker / *Caracolera de Sartori*) with 7 specimens, making this the most common snake found as a DOR over the course of this study. Figure 2 shows the distribution of the 79 specimens by year and season, with spring 2010 yielding the maximum of 10 DORs.

Discussion and Conclusion

Anthropogenic Development

Unfortunately, the expansion of any city proceeds at the cost of its surrounding natural ecosystems. The city of Monterrey was founded on 20 September 1596, but urban development was not a significant factor until after World War II, when industrial-

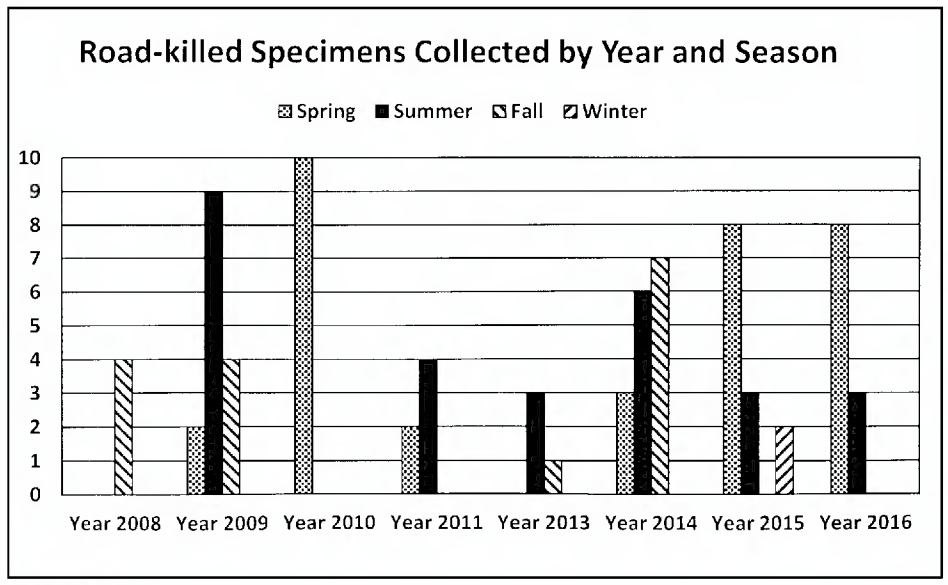


Figure 2.

ization brought about the substitution of imported products for locally created ones (Garza and Rivera, 1995; Garza, 2003; Nevárez-de los Reyes et al., 2016), at the expense of the natural surroundings. The Monterrey Metropolitan Area currently consists of 12 municipalities that contain 90% of the human population of the state. Its surface area encompasses 6,794 km^2 (10.6% of the total population of the state), with an average density of 109.1 people/km^2 (SEDESOL et al., 2007). Currently, an estimated two million vehicles are in the state, whereas 14 years ago that number was 900,000; the present estimate is equivalent to nearly 500 vehicles/1,000 people (www.elfinanciero.com.mx/monterrey/debe-frenar-expansion-urbana.html; accessed 9 September 2016.). This has increased traffic density in the Monterrey Metropolitan Area. Consistent and unplanned urban development undoubtedly represents a direct threat to the state's ecosystems. Sadly, this threat has caused some surrounding hills to become biological islands, as has occurred with Cerro del Topo Chico (Lazcano et al., 2012) and is about to happen with Cerro de las Mitras; both sites are designated as state protected areas. Another site facing a similar fate is the federally protected area of Cerro de la Silla, where the level of development on both east and west sides has disrupted some of its continuity with the Sierra Madre Oriental and the never-ending expansion of the urban stain. More and more so-called *colonias* or *fracionamientos* destroy surrounding natural habitat, with vertebrates of many species being displaced or killed. Due to economic recession, other cities in Nuevo León have not grown as exponentially as the Monterrey Metropolitan Area. We lack any information on the number of DORs in these areas. Urbanization is not just a problem in Nuevo León, it is the same in the entire country. The problem is growing at an exponential rate and putting at risk much of our biodiversity (Domínguez-Vega and Zurla, 2016; Garza, 2003).

Road Problems

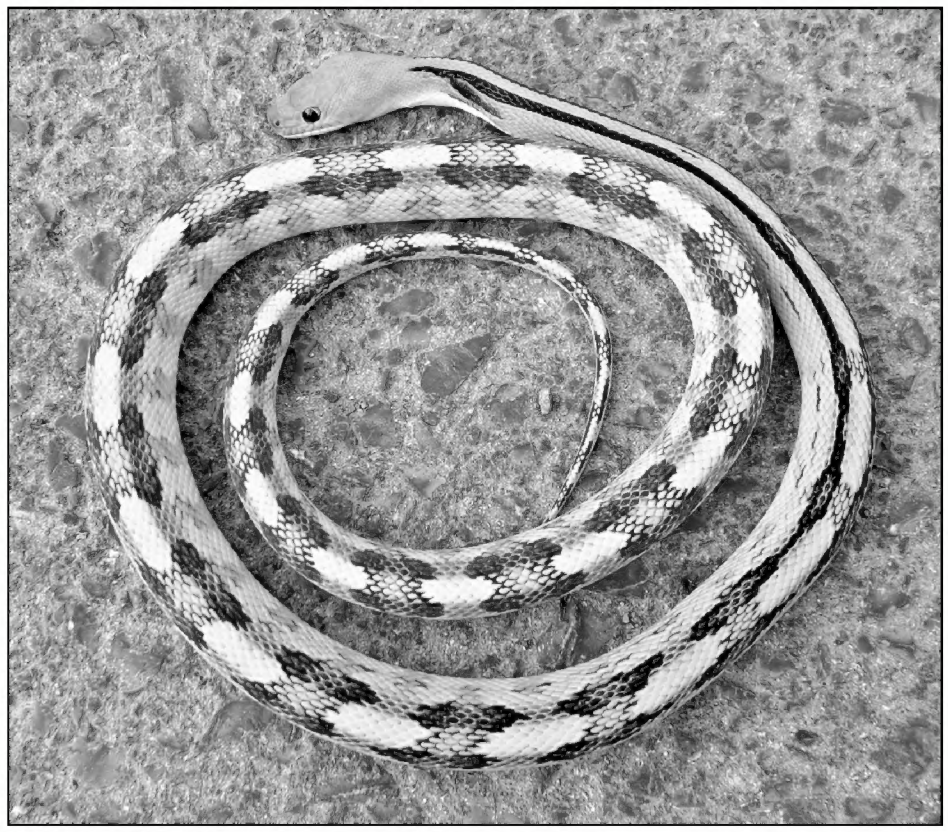
The loss of wildlife by road-kills worldwide is exorbitant. In the United States alone, one million vertebrates per day are lost (Forman and Alexander, 1998; Hels and Buchwald, 2001). In Spain the figure is 10 million per year (Cupul, 2002). In Australia the amount is 5 million per year (Forman and Alexander, 1998; Hels and Buchwald, 2001; Vargas-Salinas et al., 2011). Road-kills affect both fauna and people who are involved in accidents with large animals (Smathers, 2001), creating a large economic loss from these accidents and the loss of millions of faunal numbers (Spellerberg, 2002: pp. 225-248). Occasional human losses from such accidents are highly regrettable. These data are worrisome because in the case of the U.S. these economic figures involve only 1% of the country's surface, Perhaps, in many cases, animals that are killed on the road go unnoticed because they crawl away from the roads or are eaten by predators (Puc-Sánchez et al., 2013).

The worldwide loss of herpetofauna on roads has been widely documented (van de Ree et al., 2015; Puc-Sánchez et al., 2013); however, the impact of vehicular traffic on the Mexican herpetofauna, including that of Nuevo León, remains practically unevaluated. The principal roads in Nuevo León are federal highways 9 (Cadereyta–Allende), 40 and 40D (Saltillo–Monterrey–Reynosa), 53 (Monterrey–Miguel Alemán), 57 (San Roberto–Saltillo), 58 (Linares–San Roberto), 85 and 85D (Linares–Monterrey–Nuevo Laredo), and state highways 1 (Monterrey–Colombia), 3(Dr. Arroyo–Monclova), 20 (Santiago–Laguna de Sánchez), 54 (Monterrey-Monclova), and 61 (Dr. Arroyo–Galeana) (www.mapacarreteras.org/e2555-nuevo-leon.html; accessed 09 December 2016), and these roads are assumed to have a significant impact on local wildlife populations. Because the herpetofauna uses these roads for several reasons (Lazcano et al., 2009; Puc-Sánchez et al., 2013), conservation programs aiming to minimize the number of road-kills should be implemented.

Two recent studies (Köhler et al., 2016a, b) dealt with biological information that can be derived from the examination of snakes killed on roads in the vicinity of Chetumal, Quintana Roo, including seasonal activity, abundance, reproduction, special distribution, external morphology, diet, among other topics. In particular their (Köhler et al., 2016a) research consisted in traveling at 15-day intervals from 2010 to 2016 along a 39-km transect, reporting 433 road killed snakes belonging to 31 species.

In addition to federal and state roads, our findings also document other cases of road-kills, for example in streets within suburban areas where new housing developments are being built. This is happening in seven of the municipalities that make up the Monterrey Metropolitan Area.. In the state of Nuevo León there are 65 species of snakes (Nevárez-de los Reyes et al., 2016): here we document 31 species, representing 47.69% of the total of species of the state. Since we didn't follow a regular method, the number of specimens documented during these years (2008–2016) is relatively small. One thing that we noticed is that federal or state roads with heavy traffic (Monterrey–Colombia, Cadereyta-–Allende and Monterrey–Monclova) result in fewer road-killed individuals. This is likely because the snake populations there for years have suffered continual road-killing to a point where their numbers have diminished.

The road network in the state is being developed intensively in order to accommodate the increasing demand of goods that need to be transported among municipalities and the bordering states; however, it is critical to recognize the potential threats to all groups of biodiversity. As road networks are increased and amplified, there is also a need to implement further research on the subject to measure the impact of this phenomenon, in order to promote better roads—both to satisfy human needs and to preserve the gene pools of species living and moving about in these areas.

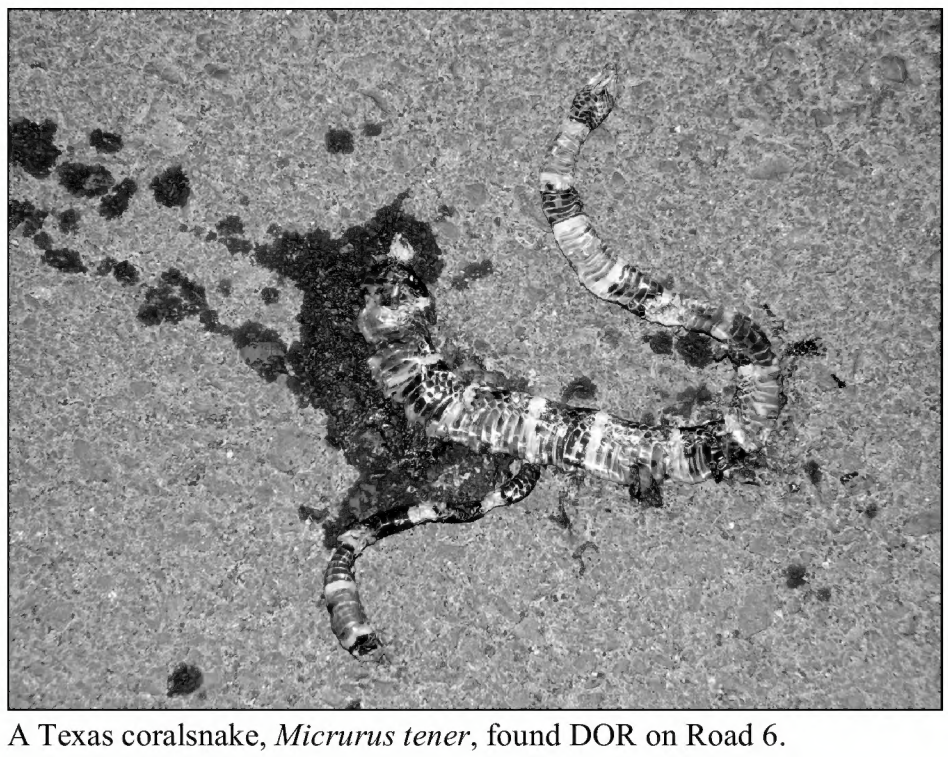


Trans-Pecos ratsnake, *Bogertophis subocularis*—a rare snake in Nuevo León—found DOR on Road 6.

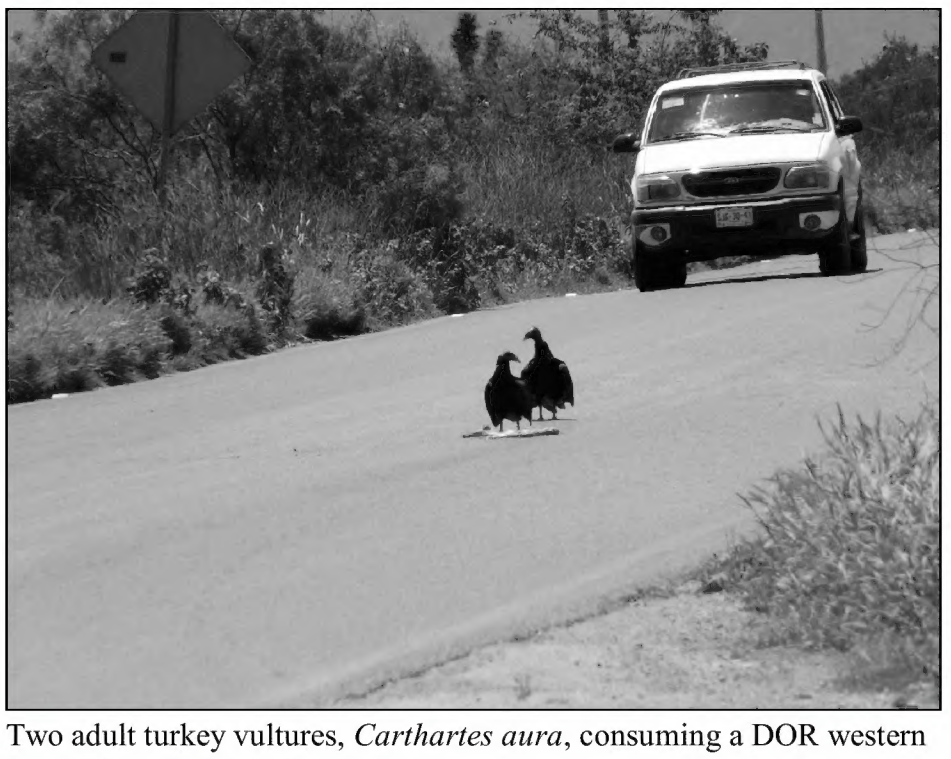
Gray-banded kingsnake, *Lampropeltis alterna*, one of the most beautiful snakes of the state, found DOR on Road 6.

A large bullsnake, *Pituophis catenifer sayi*, found DOR on Road 6.

A beautiful mountain bullsnake, *Pituophis deppei jani*, found DOR on Road 5.



A Texas coralsnake, *Micrurus tener*, found DOR on Road 6.



Two adult turkey vultures, *Carthartes aura*, consuming a DOR western coachwhip, *Coluber flagellum testaceus*.

All photographs by Manuel Nevárez de los Reyes.

Reflection

As the human population grows, so will the necessity to transport more goods to towns and cities. There will be increasing requests for better infrastructure, which includes roads. This will no doubt increase road-kills. And as exploration opens new areas for minerals, petroleum, and wood, many more pristine areas will disappear in front of our eyes—we really can't do anything about this. Any animal that is road-killed is a very unfortunate incident and represents lost genetic potential. In Mexico we are waking up to document this phenomenon, but can we do anything to diminish the number of animals killed? Although our article deals with road-killed snakes, recently Loc-Barragan et al. (2016) documented the finding on the road in the municipality of Tecuala, Nayarit, of a road-killed *Heloderma horridum*, an incredible loss for this species and the Mexican herpetofauna. It is an animal not easily found.

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Literature Cited

Andrews, K. M., and J. W. Gibbons. 2005. How do highways influence snake movement? Behavioral responses to roads and vehicles. Copeia 2005(4):772-782.

Andrews, K. M., T. A. Langen and R. P. J. H. Struijk. 2015. Reptiles: Overlooked but often at risk from roads. Pp. 271-280. *In*: R. van der Ree, C. Grilo and D. J. Smith, editors, Handbook of road ecology. West Sussex, United Kingdom: John Wiley and Sons.

Anonymous. 2000. Decretos de áreas naturales del estado de Nuevo León, México. Secretaria de Ecología y Recursos Naturales. Periódico Oficial 2000.

Aresco, M. J. 2005. The effect of sex-specific terrestrial movements and roads on the sex ratio of freshwater turtles. Biological Conservation 123(1):37-44.

Arriaga, L., J. M. Espinosa, C. Aguilar, E. Martínez, L. Gómez and E. Loa (coordinadores). 2000. Regiones terrestres prioritarias de México. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México. pp. 361-362.

Arroyave, M. P., C. Gómez, M. E. Gutiérrez, D. P. Munera, P. A. Zapata, I. C. Vergara, L. M. Andrade and K. Ramos. 2006. Impacto de las carreteras sobre la fauna silvestre y sus principales medidas de manejo. Medellín, Colombia: Revista EIA (Escuela de Ingeniería de Antioquia) Number 5:45-57.

Ashley, E. P., and J. T. Robinson. 1996. Road mortality of amphibians, reptiles and other wildlife on the Long Point Causeway, Lake Erie, Ontario. Canadian Field Naturalist 110(3):403-412.

Barrí, F. R. 2010. Evaluación preliminar de la mortandad de masto fauna nativa por colisión con vehículos en tres rutas Argentinas. Ecología Aplicada 9(2):161-165.

Beaudry, F., P. G. deMaynadier and M. L. Hunter. 2008. Identifying road mortality threat at multiple spatial scales for semi-aquatic turtles. Biological Conservation 141(10):2550-2563.

Beaudry, F., P. G. deMaynadier and M. L. Hunter. 2010. Identifying hot moments in road-mortality risk for freshwater turtles. Journal of Wildlife Management 74(1):152-159.

Benítez-López, A., R. Alkemade and P. A. Verweij. 2010. The impacts of roads and other infrastructure on mammal and bird populations: A meta-analysis. Biological Conservation 143(6):1303-316.

Bissonette, J. A., and W. Adair. 2008. Restoring habitat permeability to roaded landscapes with isometrically-scaled wildlife crossings. Biological Conservation 141(2):482-488.

Cantú-Ayala, C., M. Rovalo-Merino, J. Marmolejo-Moncivais, S. Ortiz-Hernández, and F. Seriñá-Garza (editors). 2013. Historia natural del Parque Nacional Cumbres de Monterrey, México. Universidad Autónoma de Nuevo León / Comisión Nacional de Area Protejidas, Parque Nacional Cumbres / Pronatura Noreste A.C. / Consejo de Flora y Fauna Silvestre de Nuevo León.

Carr, L. W., and L. Fahrig. 2001. Effect of road traffic on two amphibian species of differing vagility. Conservation Biology 15(4): 1071-1078.

Clark, R. W., W. S. Brown, R. Stechert and K. R. Zamudio. 2010. Roads, interrupted dispersal, and genetic diversity in timber rattlesnakes. Conservation Biology 24(4):1059-1069.

Corlatti, L., K. Hackländer, and F. Frey-Roos. 2009. Ability of wildlife overpasses to provide connectivity and prevent genetic isolation. Conservation Biology 23(3):548-556.

Cupul, F. 2002. Víctimas de la carretera: Fauna apachurrada. Gaceta CUC. Departamento de Ciencias. Centro Universitario de la Costa. México.

Dodd, C. K., Jr., K. M. Enge and J. N. Stuart. 1989. Reptiles on highways in north-central Alabama, USA. Journal of Herpetology 23(2):197-200.

Domínguez-Vega, H., and I. Zurla. 2016. Ecología urbana y herpetofauna en México: Potencial de un nicho poco explorado. Herreriana 12(1):31-34.

Fahrig, L., J. H. Pedlar, S. E. Pope, P. D. Taylor and J. F. Wegner. 1995. Effect of road traffic on amphibian density. Biological Conservation 73(3):177-182.

Forman, R. T. T., and L. E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics 29: 207-231.

Forman, R. T. T., D. Sperling, J. A. Bissonette, A. P. Clevenger, C. D. Cutshall, V. H. Dale, L. Fahrig, R. L. France, C. R. Goldman, K. Heanue, J. A. Jones, F. J. Swanson, T. Turrentine, and T. C. Winter. 2003. Road ecology science and solutions. Washington D.C.: Island Press.

Garza, G. 2003. La urbanización de México en el siglo XX. México D.F.: El Colegio de México.

Garza, G., and S. Rivera. 1995. Desarrollo económico y distribución de la población urbana en México. Pp. 17-58. *In*: A. G. Aguilar, L. J. Castro and E. Juárez, editors, El desarrollo urbano de México a fines del siglo XX. Monterrey, Mexico: Instituto de Estudios Urbanos de Nuevo León y Sociedad Mexicana de Demografía.

Gibbs, J. P. 1998. Amphibian movements in response to forest edges, roads, and streambeds in southern New England. Journal of Wildlife Management 62(2):584-589.

Gibbs, J. P., and W. G. Shriver. 2002. Estimating the effects of road mortality on turtle populations. Conservation Biology 16(6): 1647-1652.

Gibbs, J. P., and W. G. Shriver. 2005. Can road mortality limit populations of pool-breeding amphibians? Wetlands Ecology and Conservation 13(3):281-289.

Glista, D. J., T. L. DeVault and J. A. DeWoody. 2009. A review of mitigation measures for reducing wildlife mortality on roadways. Landscape and Urban Planning 91:1-7.

Grosselet, M., B. Villa-Bonilla and G. Ruiz-Michael. 2009. Afectaciones a vertebrados por vehículos automotores en 1.2 km. de carretera en el Istmo de Tehuantepec. Pp. 227-231. *In*: T. D. Rich, C. Arizmendi, D. W. Demarest and C. Thompson, editors, Proceedings of the Fourth International Partners in Flight Conference: Tundra to tropics.

Hamer, A. J., T. E. S. Langton and D. Lesbarréres. 2015. Making a safe leap forward: Mitigating road impacts on amphibians. Pp. 261-270. *In*: R. van der Ree, C. Grilo and D. J. Smith, editors, Handbook of road ecology. West Sussex, United Kingdom: John Wiley and Sons.

Hels, T., and E. Buchwald. 2001. The effect of road kills on amphibian populations. Biological Conservation 99:331-340.

Herrera-Robledo, R. 2011. Evaluación de la mortalidad de aves y mamíferos por atropellamiento en la carretera costera de Michoacán y los impactos potenciales de ampliación. Unpublished licentiate thesis, Universidad Michoacán de San Nicolás de Hidalgo. 61 pp.

Jaeger, J. A. G, J. Bowman, J. Brennan, L. Fahrig, D. Bert, J. Bouchard, N. Charbonneau, K. Frank, B. Gruber and K. T. von Toschanowitz. 2005. Predicting when animal populations are at risk from roads: An interactive model of road avoidance behaviour. Ecological Modeling 185(2-4):329-348.

Kjoss, V. A., and J. A. Litvaitis. 2001. Community structure of snakes in a human-dominated landscape. Biological Conservation 98:285-292.

Köhler, G., J. R. Cedeño-Vázquez and P. M. Beutelspacher-García. 2016a. The Chetumal snake census: Generating biological data from road-killed snakes. Part 1. Introduction and identification key to the snakes of southern Quintana Roo, Mexico. Mesoamerican Herpetology 3(3):670-687.

Köhler, G., J. R. Cedeño-Vázquez, T. Kirstein and P. M. Beutelspacher-García. 2016b. The Chetumal snake census: generating biological data from road-killed snakes. Part 2. *Dipsas brevifacies*, *Sibon sanniolus*, and *Tropidodipsas sartorii*. Mesoamerican Herpetology 3(3):689-705.

Langen, T. A., A. Machniak, E. K. Crowe, C. Mangan, D. F. Marker, N. Liddle and B. Roden. 2007. Methodologies for surveying herpetofauna mortality on rural highways. Journal of Wildlife Management 71(4):1361-1368.

Langton, T. E. S. 1989. Amphibians and roads: Proceedings of the toad tunnel conference. Bedfordshire, UK: ACO Polymer Products.

Lazcano, D., J. Banda, G. Castañeda, C. García-de la Peña and C. Solís Rojas. 2006. Notes on Mexican herpetofauna 8: Herpetofauna of the Parque Ecológico Chipinque, Nuevo León, Mexico. Bulletin of the Chicago Herpetological Society 41(7):117-123.

Lazcano, D., M. A. Salinas-Camarena and J. A. Contreras-Lozano. 2009. Notes on Mexican herpetofauna 12: Are roads in Nuevo León, Mexico, taking their toll on snake populations? Bulletin of the Chicago Herpetological Society 44(5):69-75.

Lazcano, D., J. Contreras-Lozano, S. Narváez-Torres and J. Chávez-Cisneros. 2012. Notes on Mexican herpetofauna 18: Herpetofauna of Cerro El Topo Chico Natural Protected Area, Nuevo León, Mexico. Bulletin of the Chicago Herpetological Society 47(12):149-155.

Loc-Barragan, J. A., J. P. Ramirez-Silva, and G. Woolrich-Piña. 2016. Other contributions: Distribution notes: *Heloderma horridum* (Wiegmann, 1829). Mesoamerican Herpetology 3(3):766-767.

Marchand, M. N., and J. A. Litvaitis. 2004. Effects of habitat features and landscape composition on the population structure of a common aquatic turtle in a region undergoing rapid development. Conservation Biology 18(3):758-767.

Martínez-Hernández, N. 2011. Evaluación cuantitativa y cualitativa de la mortandad de anfibios y reptiles por atropellamiento en la carretera costera Lázaro Cárdenas-Coahuayana de Michoacán. Unpublished licentiate thesis. Universidad Michoacán de San Nicolás de Hidalgo.

Nevárez-de los Reyes, M., D. Lazcano, E. García-Padilla, V. Mata-Silva, J. D. Johnson and L. D. Wilson. 2016. The herpetofauna of Nuevo León, Mexico: Composition, distribution, and conservation. Mesoamerican Herpetology 3(3):557-638.

Puc-Sánchez, J. I., C. Delgado Trejo, E. Méndoza Ramírez and I. Sauzo Ortuño. 2013. Las Carreteras como una fuente de mortalidad de fauna silvestre en México. Biodiversitas 111 (Noviembre-Diciembre):12-16.

Rosen, P. C., and C. H. Lowe. 1994. Highway mortality of snakes in the Sonoran Desert of southern Arizona. Biological Conservation 68(2):143-148.

Rudolf, D. C., S. J. Burgdorf, R. N. Conner and R. R. Schaefer. 1999. Preliminary evaluation of the impact of roads and associated vehicular traffic on snake populations in eastern Texas. Pp. 128-135. *In*: G. Evink, P. Garrett and D. Ziegler, editors, Proceedings of the 3rd International Conference on Wildlife Ecology and Transportation.. Tallahassee: Florida Department of Transportation.

Saunders, D. A., and R. J. Hobbs. 1991. The role of corridors in conservation: What do we know and where do we go? Pp. 421-427. *In*: D. A. Saunders, and R. J. Hobbs, editors, Nature conservation 2: The role of corridors. Chipping Norton, Australia: Surrey Beatty and Sons.

SEDESOL, INEGI and CONAPO. 2007. Delimitación de las zonas metropolitanas en México 2005. México, D. F., México.

SEMARNAT (Secretaría del Medio Ambiente y Recursos Naturales). 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-2010. Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. Publicada el 30 de Diciembre 2010.

Semlitsch, R. D. 2000. Principles for management of aquatic-breeding amphibians. Journal of Wildlife Management 64(3):615-631.

Smathers, W., Jr. 2001. The socioeconomic impacts of wildlife-vehicle collisions. P. 21. *In*: T. A. Messmer and B. West, editors, Wildlife and highways: Seeking solutions to an ecological and socioeconomic dilemma. 7th Annual Meeting of The Wildlife Society. Nashville, Tennessee.

Smith, L. L., and C. K. Dodd, Jr. 2003. Wildlife mortality on highway US 441 across Payne's Prairie, Alachua County, Florida. Florida Scientist 66(2):128-140.

Spellerberg, I. F. 2002. Ecological effects of roads. Enfield, New Hampshire: Science Publishers.

Steen, D. A., and J. P. Gibbs. 2004. Effects of roads on the structure of freshwater turtle populations. Conservation Biology 18(4): 1143-1148.

Steen, D. A., and L. L. Smith. 2006. Road surveys for turtles: Consideration of possible sampling biases. Herpetological Conservation and Biology 1(1):9-15.

Sullivan, B. K. 2012. Road riding. Pp. 215-218. *In*: R. W. McDiarmid, M. S. Foster, C. Guyer, J. W. Gibbons and N. Chernoff, editors, Reptile biodiversity: Standard methods for inventory and monitoring. Berkeley: University of California Press.

Sullivan, B. K, D. J. Leavitt and K. O. Sullivan. 2016. Snake communities on the urban fringe in the Sonoran Desert: Influences on species richness and abundance. Urban Ecosystems 20(1):199-206.

Trombulak, S. C., and C. A. Frissell. 1999. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14(1):18-30.

Van der Ree, R., D. J. Smith and C. Grilo. 2015. The ecological effects of linear infrastructure and traffic. Pp. 1-9. *In*: R. van der Ree, C. Grilo and D. J. Smith, editors, Handbook of road ecology. West Sussex, United Kingdom: John Wiley and Sons.

Vargas-Salinas, F., I. Delgado-Ospina, and F. López-Aranda. 2011. Mortalidad por atropello vehicular y distribución de anfibios y reptiles en un bosque subandino en el occidente de Colombia. Caldasia 33(1):121-138.

Wilcox, B. A., and D. D. Murphy. 1985. Conservation strategy: The effects of fragmentation on extinction. American Naturalist 125(6): 879-887.

Yanes, M., J. M. Velasco and F. Suárez. 1995. Permeability of roads and railways to vertebrates: The importance of culverts. Biological Conservation 71(3):217-222.

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Notes on Reproduction of Woodhouse's Toads, *Anaxyrus woodhousii* (Anura: Bufonidae)

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Abstract

A histological examination of gonads from 36 Woodhouse's toads, *Anaxyrus woodhousii*, from the Southwestern United States (Arizona, California and New Mexico) was conducted. The smallest mature male (sperm in lumina of seminiferous tubules) measured 68 mm snout–vent length (SVL) and was from July (New Mexico). One smaller male (SVL = 53 mm) from Arizona was determined to be a juvenile. The smallest mature female (spawning condition) measured 71 mm SVL and was collected in July from New Mexico. Males are capable of breeding from March into July. Females of *A. woodhousii* are in spawning condition from March into October. *Anaxyrus woodhousii* in southwestern North America has an extended period of reproductive readiness that extends from March into October.

Anaxyrus woodhousii (Girard, 1854) ranges from Montana and North Dakota south to the Gulf of Mexico, west to southeast California and south into Mexico; there are isolated populations in the northwest (Powell et al., 2016). The most detailed information on *A. woodhousii* reproduction is by Bragg (1940) and Sullivan (2005). In this paper I present data from a histological examination of *A. woodhousii* gonadal material from Arizona, California and New Mexico. Utilization of museum collections for obtaining reproductive data avoids removing additional animals from the wild.

A sample of 35 adult (Table 1) and one juvenile *A. woodhousii*, collected 1953 to 1968, was examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA (see Appendix). The sample comprised: from Arizona (N = 10), four males, mean SVL = 83.8 mm ± 7.7 SD, range = 73–93 mm, five females, mean SVL = 84.8 mm ± 4.7 SD, range = 78–88 mm, and one juvenile (SVL = 53 mm); from California (N = 13), four males, mean SVL = 80.0 mm ± 3.6 SD, range = 77–84 mm, nine females, mean SVL = 80.8 mm ± 8.2 SD, range = 73–93 mm; from New Mexico (N = 13), ten males, mean SVL = 75.4 mm ± 7.6 SD, range = 68–88 mm, three females mean SVL = 85.3 mm ± 13.2 SD, range = 71–97 mm.

A small incision was made in the lower part of the abdomen and the left testis was removed from males and a piece of the left ovary from females. Gonads were embedded in paraffin, sections were cut at 5 μm and stained with Harris hematoxylin followed by eosin counterstain (Presnell and Schreibman, 1997). Histological slides are deposited in LACM.

Testicular morphology is similar to that of *I. nebulifer* (see Goldberg, 2017a). Two stages were present in the testicular cycle (Table 1): (1) Sperm abundant; open sperm cysts discharged sperm into lumina of seminiferous tubules which contained a resultant intertwined sperm mass; (2) Sperm reduced; few open sperm cysts remained, most lumina of seminiferous tubules were devoid of sperm. The smallest reproductively active male (abundant sperm) measured 68 mm SVL (LACM 88530) and was collected in New Mexico during July. One male collected in August from Arizona (LACM 88469) measured 53 mm SVL and was considered a juvenile. Primary spermatocytes predominated in the seminiferous tubules of this testis; only a few sperm were present. A testis in this condition was classified as juvenile by Ogielska and Bartmańska (2009). Wright and Wright (1949) reported 56 mm as the minimum size for maturity of male *A. woodhousii*. The males with reduced sperm from July and September (Table 1) may have already completed spawning. Those from March would have possibly produced abundant sperm later in the reproductive season.

Ovarian morphology is similar to that of *I. nebulifer* (see Goldberg, 2017a). Two stages were present in the ovarian cycle (Table 1): (1) Spawning condition: ovary is filled with mature oocytes filled with yolk droplets; the surrounding layer of follicular cells is thinly stretched; (2) Not spawning: immature early diplotene oocytes predominated. The smallest reproductively active female measured 71 mm SVL (LACM 123245) and was collected in July from New Mexico. Wright and Wright (1949) reported the minimum size for mature *A. woodhousii* females was 59 mm SVL.

Follicle atresia is the spontaneous degeneration and resorption of follicles and may occur at any stage of development (Saidapur, 1978). It is not understood why some follicles complete development and ovulate while others undergo atresia

Table 1. Monthly stages in the testicular and ovarian cycles of 35 adults of *Anaxyrus woodhousii* from Arizona, California and New Mexico.

Arizona males (N = 4)			**Arizona females (N = 5)**		
Month	**Sperm abundant**	**Sperm reduced**	**Month**	**Spawning condition**	**Not spawning**
April (1)	1	0	April (2)	2	0
May (1)	1	0	May (2)	1	1
July (1)	0	1	July (1)	0	1
September (1)	0	1			
California males (N = 4)			**California females (N = 9)**		
Month	**Sperm abundant**	**Sperm reduced**	**Month**	**Spawning condition**	**Not spawning**
March (4)	2	2	March (5)	4	1
			July (1)	1	0
			October (3)	2	1
New Mexico males (N = 10)			**New Mexico females (N = 3)**		
Month	**Sperm abundant**	**Sperm reduced**	**Month**	**Spawning condition**	**Not spawning**
June (1)	1	0	June (1)	1	0
July (9)	7	2	July (1)	1	0
			August (1)	1	0

(Saidapur, 1978). In atresia the ooplasm is phagocytized by follicle cells, leaving a mass of pigmented material which gradually decreases. Incidences of follicle atresia increase late in the reproductive season when follicles that initiated but did not complete yolk deposition are resorbed (Goldberg, 1973). This was noted in one *A. woodhousii* from California collected late in the spawning season (October) which exhibited numerous atretic oocytes. Follicular atresia was noted in the following females in spawning condition: Arizona (3/3); California (0/9); New Mexico (1/3). One female from Arizona collected early in the spawning season in May (LACM 88464) in the "Not spawning" category would have been originally classified in the "Spawning" category as spawning appeared imminent. However the ovary exhibited a massive atresia in which virtually all follicles were replaced by amorphous brown masses. This female would have been being unable to reproduce. A similar case was reported from California for *Hyliola cadaverina* from April (Goldberg, 2017b). Thus, atresia has an important role in fecundity by reducing the number of ovulated oocytes.

Table 2. Months of breeding by state for *Anaxyrus woodhousii* * not all females breed, each year; **activity season only, breeding dates are not given.

State	**Times of breeding**	**Source**
Arizona	February–September	Brennan & Holycross, 2009
Arkansas	late March–May	Trauth et al., 1990
California	March–July	Stebbins & McGinnis, 2012
Colorado	April–June	Hammerson, 1999
Colorado	April through June	Young, 2011
Idaho	March–July	Groves, 1989
Iowa	May through June	LeClere, 2013
Kansas	Late March–late August	Collins et al., 2010
Louisiana	March–early July	Dundee & Rossman, 1989
Missouri	April–May	Johnson, 2000
Montana	commence in April*	Werner et al., 2004
Nebraska	May and early June	Hardin & Janovy, 1988
Nebraska	April–September**	Ballinger et al., 2010
Nebraska	Mid-spring	Fogell, 2010
New Mexico	April–June	Degenhardt et al., 1996
Oklahoma	March–mid-August*	Bragg, 1940
Oklahoma	March–August	Sievert & Sievert, 2011
S. Dakota	Early March–early August	Kiesow, 2006
Texas	March–August	Garrett & Barker, 1987
Texas	March–June	Long, 1987
Texas	February–September	Tipton et al., 2012
Wyoming	Spring and summer	Baxter & Stone, 1980
Pacific NW	Late April through July	Jones et al., 2005
Not Given	March–July	Wright & Wright, 1949

Months of *A. woodhousii* breeding are given in Table 2. The reason for the extended reproductive season, in some cases, may result from not all *A. woodhousii* breeding at the same time (Wheeler and Wheeler, 1966). Moreover, some of the spans of breeding in Table 2 may be only approximations since it is unknown if breeding occurred earlier or later in the year than the dates published. For example, data in Table 1 indicate *A. woodhousii* females from October in California are in spawning condition. However it is uncertain when these mature eggs would have been spawned. Retention of mature follicles permits breeding at any time climatic conditions are suitable (Long, 1987). This apparently occurs in Oklahoma where Bragg (1940) reported *B. woodhousii* reproduced in late summer after having bred earlier during that year. Additional observations of *B. woodhousii* reproduction from throughout its extensive geographic range will likely extend the periods in which breeding may occur.

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Literature Cited

Ballinger, R. E., J. D. Lynch and G. R. Smith. 2010. Amphibians and reptiles of Nebraska. Oro Valley, Arizona: Rusty Lizard Press.

Baxter, G. T., and M. D. Stone. 1980. Amphibians and reptiles of Wyoming. Cheyenne: Wyoming Game and Fish Department,

Bragg, A. N. 1940. Observations on the ecology and natural history of Anura. II. Habits, habitat, and breeding of *Bufo woodhousii woodhousii* (Girard) in Oklahoma. American Midland Naturalist 24(2):306-321.

Brennan, T. C., and A. T. Holycross. 2009. A field guide to amphibians and reptiles in Arizona. Phoenix: Arizona Game and Fish Department.

Collins, J. T., S. L. Collins and T. W. Taggart. 2010. Amphibians, reptiles, and turtles in Kansas. Eagle Mountain, Utah: Eagle Mountain Publishing, LC.

Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. Amphibians and reptiles of New Mexico. Albuquerque: University of New Mexico Press.

Dundee, H. A., and D. A. Rossman. 1989. The amphibians and reptiles of Louisiana. Baton Rouge: Louisiana State University Press.

Fogell, D. D. 2010. A field guide to the amphibians and reptiles of Nebraska. University of Nebraska–Lincoln.

Garrett, J. M., and D. G. Barker. 1987. A field guide to reptiles and amphibians of Texas. Houston: Gulf Publishing Company.

Goldberg, S. R. 1973. Ovarian cycle of the western fence lizard, *Sceloporus occidentalis*. Herpetologica 29(3):284-289.

————. 2017a. Reproduction in Gulf Coast toads, *Incilius nebulifer* (Anura: Bufonidae) from Texas. Bulletin of the Chicago Herpetological Society 52(9):159-161.

————. 2017b. Notes on reproduction of California treefrogs, *Hyliola cadaverina* (Anura: Hylidae) from Riverside, California. Sonoran Herpetologist 30(1):5-7.

Groves, C. 1989. Idaho's amphibians & reptiles, description, habitat and ecology. Boise, Idaho: IDFG Nongame Trust Fund.

Hammerson, G. A. 1999. Amphibians and reptiles in Colorado, Second edition. Niwot, Colorado: University Press of Colorado.

Hardin, E. L., and J. Janovy, Jr. 1988. Population dynamics of *Distoichometra bufonis* (Cestoda: Nematotaeniidae) in *Bufo woodhousii*. Journal of Parasitology 74(3):360-365.

Johnson, T. R. 2000. The amphibians and reptiles of Missouri. Jefferson City: Missouri Department of Conservation.

Jones, L. L. C., W. P. Leonard and D. H. Olsen, editors. 2005. Amphibians of the Pacific Northwest. Seattle: Seattle Audubon Society.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. Pierre: South Dakota Department of Game, Fish and Parks.

LeClere, J. B. 2013. A field guide to the amphibians and reptiles of Iowa. Rodeo, New Mexico: ECO Herpetological Publishing & Distribution.

Long, D. R. 1987. A comparison of energy substrates and reproductive patterns of two anurans, *Acris crepitans* and *Bufo woodhousei*. Comparative Biochemistry and Physiology Part A 87(1):81-91.

Ogielska, M., and J. Bartmańska. 2009. Spermatogenesis and male reproductive system in Amphibia—Anura. Pp. 34-99. *In*: M. Ogielska, editor, Reproduction of amphibians. Enfield, New Hampshire: Science Publishers.

Powell, R., R. Conant and J. T. Collins. 2016. Peterson field guide to reptiles and amphibians of eastern and central North America, Fourth edition. Boston: Houghton Mifflin Harcourt.

Presnell, J. K., and M. P. Schreibman. 1997. Humason's animal tissue techniques. 5th ed. Baltimore: The Johns Hopkins University Press.

Saidapur, S. K. 1978. Follicular atresia in the ovaries of nonmammalian vertebrates. Pp.225-244. *In*: G. H. Bourne, J. F. Danielli and K. W. Jeon, editors, International review of cytology, Volume 54. New York: Academic Press.

Sievert, G., and L. Sievert. 2011. A field guide to Oklahoma's amphibians and reptiles. Oklahoma City: Oklahoma Department of Wildlife Conservation.

Stebbins, R. C., and S. M. McGinnis. 2012. Field guide to amphibians and reptiles of California, Revised edition. Berkeley: University of California Press.

Sullivan, B. K. 2005. *Bufo woodhousii* Girard, 1854 Woodhouse's Toad. Pp. 438-440. *In*: M. Lannoo, editor, Amphibian declines: The conservation status of United States species. Berkeley: University of California Press.

Tipton, B. L., T. L. Hibbitts, T. D. Hibbitts, T. J. Hibbitts and T. J. Laduc. 2012. Texas amphibians: A field guide. Austin: University of Texas Press.

Trauth, S. E., R. L. Cox,, B. P. Butterfield, D. A. Saugey and W. E. Meshaka. 1990. Reproductive phenophases and clutch characteristics of selected Arkansas amphibians. Proceedings – Arkansas Academy of Science 44(29):107-113.

Werner, J. K., B. A. Maxell, P. Hendricks and D. L. Flath. 2004. Amphibians and reptiles of Montana. Missoula, Montana: Mountain Press Publishing Company.

Wheeler, G. C., and J. Wheeler. 1966. The amphibians and reptiles of North Dakota. Grand Forks: The University of North Dakota.

Wright, A. H., and A. A. Wright. 1949. Handbook of frogs and toads of the United States and Canada, Third edition. Ithaca, New York: Comstock Publishing Associates, Cornell University Press.

Young, M. T. 2011. The guide to Colorado reptiles and amphibians. Golden, Colorado: Fulcrum Publishing.

Appendix

Anaxyrus woodhousii from Arizona, California and New Mexico examined by county from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA. **Arizona**—PIMA: 88452, 88455; YUMA: 26274, 28804, 88463-88465, 88467, 88469, 88471, 88473. **California**—IMPERIAL: 12041, 12042, 12044, 12047, 88476, 88483, 88491, 88494, 88495, 88502-88504, 88506. **New Mexico**—CHAVES: 1210, 1211; DONA ANA: 64176, 64178; LUNA: 59347, 88530, 88532, 88535, 88537, 88539, 115333, 115335, 123245; SOCORRO: 76411.

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Steven and Ellie

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On 21 October of this hallowed year of 2017, I towered above a Tiger Rattlesnake (*Crotalus tigris*) that was wedged into the tight vertical crevice of a boulder. I would normally devote many words and over 1000 horsepower of energy writing a description of the whole scene, but since we have photos, we direct your eyes to Figures 1 and 2. Seeing this particular snake in this particular boulder crevice brought about an epiphany upon my person. Said epiphany went something like "I sure do miss our radio-tracking." Yes, it was a simple epiphany. Whoever said that epiphanies need to be complicated to be a good? (Probably nobody. So remember—you saw it here first! These columns are pure genius at work).

I *do* miss radio-tracking. I miss everything about it. To me, following the blips was following my bliss. I knew that a cool herp waited at the end of each tracking session. Some of these herps were new to me, and I was just starting to learn about them. Some were old friends, and any ensuing write-up would be yet another grain of sand on top of the termite mound of knowledge being gathered on that particular animal. Even when I couldn't see them, I *still* knew where they were, because the signal penetrated the ground or cover boulder that they were under. Many was the time I went 'round and 'round a boulder, touching the antenna down to the boulder itself until the loudest signal told me *exactly* where the herp in question was located. I would then take a knee, flop to the ground, or do whatever was necessary to find a way to see that herp. More times than not, I would find a subtle entrance hole or crevice that led to a visual on the herp being tracked. That is how I know that no matter how large, thick or dense the cover object was, the signal did not lie. The herp in question was exactly where the signal said it would be. Then would come the write-up. While at times the data gathering and write-ups were tedious (especially at night), it was usually a pleasant way to pass the time. I particularly enjoyed trying to make the words paint the perfect picture of what the eye was seeing. The datasheets only allowed for three sentences. As I was the person who created these datasheets, the three sentence allowance for a description was purposeful. It forced the observer to be brief and concise. In the end, even the most painstakingly written description winds up as a couple of check marks in the columns of the almighty spreadsheet. "Cover object: prickly pear. Check. Boulder: Check." And so on. But by far the best part of all with radio-tracking is the absolute scientific certainty that the animal the observer is seeing is who he or she thinks it is. Now that the telemetry is behind me, if I am trying to prove a herp is who I think it is, I am forced to go through a rather disorganized series of notes and images to get there. Even if that extreme effort is pursued, it is often for naught—especially with herps that are lodged in crevices or tight entrance holes. The angle of flank presented to the observer/photographer is seldom enough to capture the same character twice. Without the benefit of telemetry, I can usually only be certain of the shelter the herp is occupying. Which herp is in said shelter is often *thought* to be this one or that one, but there can't always be the certainty that telemetry provides.

But no, all the daydreaming about how great telemetry was ends when I think about doing it again. There are thousands of reasons not to pursue this direction any longer. Many of these reasons carry a dollar sign in front of them. There is also an enormous time investment involved. But the biggest reason for my not doing it again is that I no longer have the heart or stomach for it. I can no longer justify hauling some critter out of the harmony of nature to stick something on or in it that allows me to spy on it at will. If I could just be a little more like many of my peers, I'd go back to it all in heartbeat! And so, my only alternative is to do the best I can at keeping track of the herps under my watch as though I am watching them through an imaginary pane of glass. Back off, hands off, take notes, take photos, and let's see what happens. If radiotelemetry taught me anything, it is the importance of the ground that the few herps I have under watch live on and in. That's what matters most. By

Figure 1. The epiphany crack, also known as *Crotalus tigris* # 12 (Ct12) "Ellie" Site 77. This image was taken 14 November 2015. At that time, transmittered female Ct12 "Ellie" was occupying the vertical crevice in the center boulder. Image by the author.

Figure 2. Taken 22 October 2017 by Martin J. Feldner. A view into the epiphany crack. We *think* this is Ellie, but can't be sure as none of our study snakes carry working transmitters anymore.

Figure 3. *Crotalus tigris* #11, Ct11, "Steven" as viewed in the same crevice as Figures 1 and 2. This image, taken 16 November 2013, and the transmitter inside him, proved that Steven had visited this crack 2 years prior to Ellie using it. Image by the author.

zeroing in on the shelter sites of overwintering herps, I am finding the most important patch of ground that they occupy. The conservation implications are enormous.

Speaking of the important chunks of ground they live on or in, we go back to the boulder in Figure 1, and explain some things that I *know* to be true about it. Telemetry taught me this boulder was located on the upslope end of a rather major structure that occupies the mid-northeast side of Iron Mine Hill. Were we to box in this structure, it would form a rectangle roughly 15 meters wide east-west by 30 meters long north-south. Four of the 11 telemetered Iron Mine Hill Tiger Rattlesnakes overwintered within that structure. It was an absolute cornucopia of perfect boulders for our quarry—talus, rubble, crevices, soil holes. Whatever terrain one can imagine as herp hidey holes for numerous species was nearby. Meanwhile, several others were less than 30 meters away. In other words, the place was in the heart of Tiger Rattlesnake Central. Two different Tigers used the crevice in Figure 1. The first Tiger ever to be observed here was a male. He was *Crotalus tigris* #11, "Steven." He was first viewed and photographed in this crack on 16 November 2013 (Figure 3). His previous tracking event was exactly two weeks earlier, on 2 November of 2013. At that point in time, he was in a crevice roughly 30 meters downslope, with a female Tiger, *Crotalus tigris* #12, "Ellie." Just when it appeared that he was going to overwinter with a favored female companion, he left

Figure 4. Kristin Berry (left center) and Laura Stockton (right center) checking out who we *think* is Ellie in the epiphany crack on 6 March 2016. Suizo Wash and the Suizo Mountains proper can be seen in the background. Image by the author.

her and headed into the crevice under discussion. Ellie remained put. Steven's next tracking event occurred on 30 November, and to make a short story even shorter, he was gone, and never returned to that crevice again (not that we know about, anyway).

We now turn the hands of time forward almost exactly two years. The next time that a Tiger Rattlesnake was viewed in my epiphany-causing boulder crevice was 14 November 2015. As we were still using telemetry, we were able to ascertain that this time it was Ellie in there. In a complete role reversal, she did exactly what Steven had done two years earlier. She was viewed in the communal crevice with Steven on 31 October of 2015. But on this go around, it was *she* who left *him*! Moving forward, we will now call this particular boulder by what is suggested in Figure 1: Site 77. Ellie was in Site 77 for the very last tracking session of the Suizo Mountain Project, which occurred on 30 January, 2016. Her transmitter was the very last one to finally wink out, two days later. We continued to visit her, or at least we are guessing it was her, throughout the winter of 2016 (Figure 4). The last time we saw her there for this go around of the overwintering cycle was on 25 March of 2016. By 7 April, she was gone—but (maybe) not quite out of our lives. She, or possibly Steven, or possibly yet another Tiger, was viewed in Site 77 on 5 November of 2016, and again 28 January of 2017. My next visit to Site 77 was on 21 October, which takes us back to the beginning of this article. Hopefully now, any suggestions of epiphanies or confusing written rants brought about by epiphanous notions will now make sense to the reader. While I am well over 90% certain this Tiger is Ellie, the fact that I am not 100% sure is extremely frustrating to me. Of course, I could easily haul her out and do a PIT tag reading—but there goes my chance to witness seeing her ever come back to the place again. I enjoy seeing a Tiger—*any* Tiger—too much to risk losing it forever by using such cretin methods.

Our telemetry study lasted nearly 15 years. Over that course of time, we tracked both sexes of three species of rattlesnake. There were several instances of pairings in rattlesnakes that led me to hypothesize that there was something more going on than simple reproduction. These were prolonged pairings, where the same couple gathered again and again through the years. They converged and stayed together outside of what normally might

Figure 5. Unknown male Tiger Rattlesnake courting Ellie, 26 August 2012. Image by Martin J. Feldner.

be described as the reproductive periods. With the Western Diamond-backed Rattlesnakes (*Crotalus atrox*), there are three instances of what I'm talking about that leap into my mind. Further thinking and data mining with the *atrox* would likely produce more. There was also a similar instance with a pair of Black-tailed Rattlesnakes (*Crotalus molossus*). With the Tiger Rattlesnakes, we had Steven and Ellie behave in this fashion. Steven entered the study during our one and only big rattlesnake roundup, which occurred on 17 September 2011. I sent emails far and wide encouraging people to come out for an evening of fun and herping. The desire for my company was so strong locally that out of 150 people emailed, six showed up—three of whom were regulars on our plot. Nevertheless, our big event proved a success, as it netted us two Black-tailed Rattlesnakes, (our first look at "Gus," see "Ode to Gus" in the July 2016 *Bulletin*), as well as *Crotalus tigris* #11, or Ct11, Steven. Ct11 was found by Steven Condon, who out of boredom, tagged along with his father Paul that night. To honor his find, we named Ct11 "Steven." This was as close as one got to a ticker tape parade on our plot. Steven (the person) accepted the honor without any outward display of the joyous pride that *must* have been welling up inside of him. The young man was downright stoic!

Crotalus tigris #12, Ct12, entered the study on the evening of 7 June 2012. She was found by Marty Feldner, who was just beginning to become a regular at the Suizo Mountain Plot. We eventually named Ct12 "Ellie," to honor Marty's mother. (She was every bit as stoic as Steven at receiving the news that a venomous snake had been named after her.) Ellie (the snake) was found within 30 meters of where Steven was found the previous summer. Both snakes were close to *Crotalus atrox* winter den #5 on the hill, which in abbreviated form is known as "AD5," (Atrox Den #5). The den is located on the upper east side of Iron Mine Hill, which is a hefty stone's throw from everything that is discussed next.

For the first winter and spring of tracking Steven, there was no Ellie in the game. That is probably because I completely overlooked her. The dates that are about to be relayed are important due to their almost split-second consistency. On 22 October 2011, Steven was tracked to his Site 4, a horizontal, northwest-

Figure 6. Seven days later, Steven courting an unknown female Tiger Rattlesnake, 2 September 2012. Image by Martin J. Feldner.

facing narrow crevice about one meter above ground level in a massive, steep 3-meter-tall mini-cliff-face kind of boulder structure. Had I looked in that crevice more carefully, I would have likely seen Ellie coiled behind him. In all I visited Steven at Site 4 on five different occasions, again, focusing only on the obvious in that narrow crack. The last time I saw him there in 2011 was 12 November. By 19 November, he had relocated to AD5, and the excitement of having a Tiger go into a well-known *atrox* den had me forgetting all about Site 4. But almost exactly one year later, I was served a reminder of what Site 4 was all about.

On 10 June 2012, the very first tracking session with Ellie revealed a little of what was about to come. She was buried in a small boulder shelf that Steven had used on 15 April. There were a couple of occasions through the years where the pair was within a pebble's toss of each other in April, but springtime mating has not been witnessed with Tiger Rattlesnakes. Once the normal reproductive season began (August–Early September) they were *never* found together—or even close together. Ellie was found being wooed by an unknown male Tiger on 26 August 2012, and Steven was found courting an unknown female seven days later (Figures 5 and 6). The one and only copulation event witnessed in the Suizo Mountain project was on 7 September of 2013, and this involved Steven and Ct13, "Katey" (Figure 7). (Ellie was over 400 meters away when this occurred.)

Figure 7. Steven in full coitus with *Crotalus tigris* #13, Ct13, "Katey." Steven and Ellie were never viewed together during the thick of the late August/early September mating period. Image taken 7 September 2013 by Martin J. Feldner.

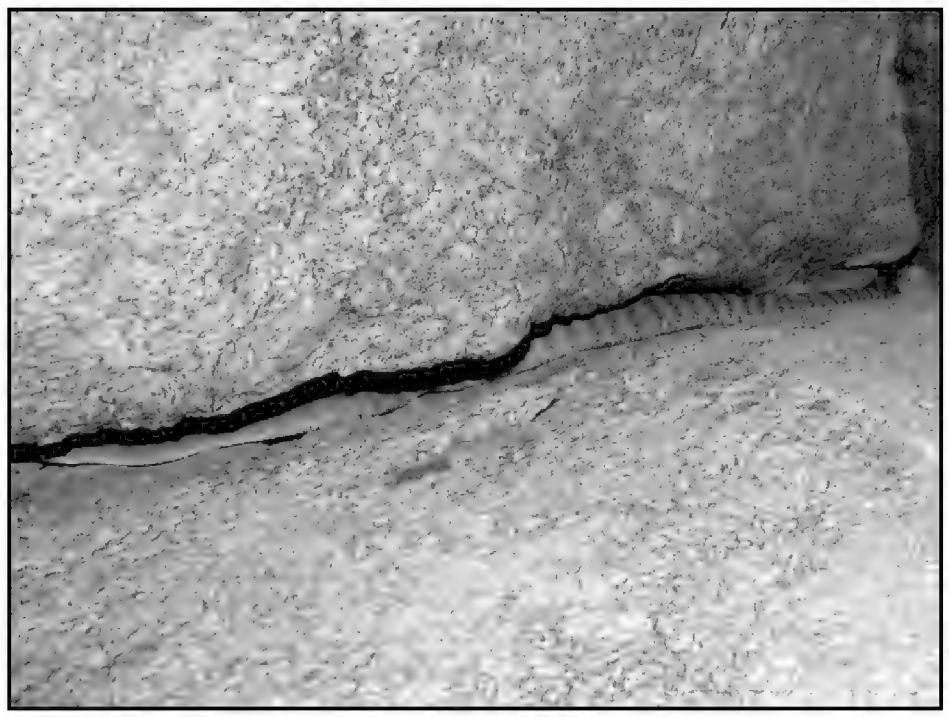


Figure 8. Within moments of the author tracking Ellie to the crevice in the background, Steven came whizzing past to join her. See Figure 9. Image taken 20 October 2012 by the author.

Figure 9. As soon as Steven arrives, he assumes his position at the front of the crevice, and does not seem to move a muscle for two months. Ellie is roughly 30 cm behind him. The pair never touched each other that we witnessed, over several visits over several years. Image by the author.

On the evening of 20 October 2012, I tracked Ellie to Steven's Site 4. I had just finished taking data on her, and switched the signal over to Steven. The signal was so loud it nearly blew my eardrums out, and so I started dialing the volume down. While I was doing that, a Tiger Rattlesnake came crawling across the opening of that crevice, and jetted inside. Somehow, some way, I had my camera ready, and was able to get some images of the arrival of this Tiger. It was Steven! (See Figures 8 and 9). Steven promptly assumed a coil posture that did not change at all until 19 January 2013. Ellie was behind and to the right of him, their coils were never closer than 30 cm apart. There was no courtship performed that we witnessed, with well over a dozen visits. The only time that things changed was on that 19 January date. Steven was viewed and photographed outside the crevice. I do believe that the team that tracked him that day saw him just about to move out. By 27 January, a week later, he had shifted over to AD5. So, he arrives in late October, seems to just stand guard over her, and leaves her in the dead of winter. What's up with that?

On October 25 of 2013, the pair was together again, in that same crevice, with the same "he in the front, she in the back" positions assumed. This time, Steven did not tarry as long, but moved out on 16 November, where he was viewed and photographed in the "epiphany crack" (Figure 3). He eventually shifted back to AD5, and she remained for the winter. In the fall of 2014, the two gave it a break. Ellie overwintered instead with female Tiger Ct13—the Tiger that Steven mated the year before! What's up with *that*? On 31 October of 2015, the pair was viewed together again in the communal crevice. Steven had moved over 500 meters to join her from his previous tracking session. Once again, they assumed their same sanctified postures in the crevice. They did not stay together long. On 14 November, she had jetted off to the epiphany crack, and he went back to AD5. As the Windies nearly killed me on that October 2016 Booger Hollow death march (see November and December 2016 issues of the *Bulletin*), I was unable to move well enough to see what developed between the two that fall. I look forward to seeing what will develop with the pair in the fall of 2018.

In order to ascertain some of what might cause Steven and Ellie to behave the way that we just described, we first need to paint a complete picture of what we know about the two. Many of us have been taught that one can't ascertain the age of a rattlesnake by counting the rattles. This is true, but should not confuse one into thinking that the rattle does not indicate age. It is difficult to think of any other feature on any type of snake that

Figure 10. Size comparison image. (Left) Ct11, Steven, as taken at capture, 17 September 2011. (Right) Ct12, Ellie, as taken on the night of her capture, 7 June 2012. The author speculates that these snakes are of similar age, and their behavior suggests something other than reproduction as the reason for getting together. Lefthand image by Paul T. Condon; righthand image by the author.

has a more obvious way of indicating age than the rattle on a rattlesnake. A rattlesnake with very few rattle segments that are tapered with a button at the end is a young snake. A larger rattlesnake with a long string of rattles that are tapered is just entering prime of life. A rattlesnake with a string of rattles that reflects only the slightest taper is aging, and no taper at all indicates a very mature snake.

If we look at the rattles on Steven and Ellie, we see that both are in the "slight taper" category. Steven had a snout–vent length (SVL) of 722 mm (28.4 inches), while Ellie's SVL was 670 mm (26.3 inches). Steven rang in with a mass of 353 grams, while Ellie registered 295 grams, or just over 2 ounces less than Steven's mass. Allowing for the sexual size dimorphism in Tiger Rattlesnakes (see Goode et al., 2016: pp. 612-614), their size, as well as their rattle shapes, would serve to indicate a similar age (see Figure 10 for comparative images). The fact that they were captured close together, albeit at different times, also might indicate some kind of closeness that extends beyond coincidence. While blood samples of both are in hand, they have never been processed. My own guess, which is speculation to a degree that most would not dare to venture, is that they are brother and sister. If they are brother and sister, does that mean they would not normally mate? Experts say otherwise—males exist to mate females, period. Any pairings are simply a form of males keeping tabs on the ladies, period. This is certainly a possible scenario—he is just getting close to her because he wants to mate with her in the future. This is all merely a form of pair bonding, and can be nothing more than that. That is the safe way of thinking with rattlesnake aficionados. But what if there is something more to these pairings than just "see you now, mate you later" scenarios? I for one think there is something else going on. If that something else could be proven, it would revolutionize the way the experts look at rattlesnake reproduction. But I can't prove it. Even if Steven and Ellie are brother and sister, that would still not be proof enough. We have a long uphill battle to fight if we are ever to change the perceptions and paradigms that surround rattlesnake reproduction. Meanwhile, it remains my opinion that rattlesnakes are smarter than we think.

This here is Roger Repp, signing off from Southern Arizona, where the turtles are strong, the snakes are handsome, and the lizards are all above average.

Literature Cited

Goode, M., M. R. Parker, M. J. Feldner and R. A. Repp. 2016. Tiger Rattlesnake, *Crotalus tigris* (Kennicott 1859). Pp. 607-655. *In*: G. W. Schuett, M. J. Feldner, C. E. Smith and R. S. Reiserer, editors, Rattlesnakes of Arizona. Volume 1: Species accounts and natural history. Rodeo, New Mexico: ECO Publishing.

Minutes of the CHS Board Meeting, October 13, 2017

Rich Crowley called the meeting to order at 7:30 P.M. Board members John Bellah, Lisette Chapa, Linda Malawy and Jessica Wadleigh were absent. The minutes of the September 15 board meeting were read and accepted.

Officers' Reports

Treasurer: Andy Malawy went over the September financial reports.

Membership secretary: Mike Dloogatch read the list of expiring memberships. There were more new than expiring memberships this month. E-mailed reminders seem to be working; more people are renewing.

Media secretary: Kim Klisiak will step in to fill the Media Secretary position for the remainder of this year.

Sergeant-at-arms: Attendance at the September 27 general meeting was 22.

Committee Reports

Shows: Dick Buchholz is stepping down as show chairman; he will continue to volunteer at shows. Mike Scott and Gail Oomens have agreed to co-chair the position. They will get together with Dick to get all necessary contact info regarding current and ongoing shows. They would like to add an email to the website (showrequest@chicagoherp.org).

Junior Herpers: Frank Sladek and Rich Lamszus have discussed the possibility of holding six meetings instead of 12, or six meetings and six workshops.

Library: Mike Dloogatch moved to allocate $500 for new books for the library in 2018. Mike Scott seconded. The motion passed unanimously.

Nominating committee: The committee has chosen a slate. An absentee ballot will be included in the October *Bulletin*.

ReptileFest: Frank Sladek has agreed to chair next year's 'Fest, with assistance from James Krause as co-chair. Both will get together with John Archer and get the ball rolling ASAP. Frank emphasized the need to obtain new sponsorships and to do a better job of getting the word out to the local community.

Old Business

Scanning old *Bulletins*: Material was brought downstate to John Palis, to move forward on scanning the 1990–1995 *Bulletin*s into pdf files.

Rich Crowley has used the current membership list to create demographics charts by membership level and ZIP code.

New Business

Mike Dloogatch moved to authorize the CHS grants program to continue in 2018, with funds to be allocated by next year's board. Gail Oomens seconded the motion, which then passed unanimously.

The meeting adjourned at 9:30 P.M.

Respectfully submitted by recording secretary Gail Oomens

Herpetology 2017

In this column the editorial staff presents short abstracts of herpetological articles we have found of interest. This is not an attempt to summarize all of the research papers being published; it is an attempt to increase the reader's awareness of what herpetologists have been doing and publishing. The editor assumes full responsibility for any errors or misleading statements.

SNAKE MOVEMENT AND ACTIVITY

E. A. Eskew and B. D. Todd [2017, Copeia 105(3):584-591] note that movement and activity patterns are fundamental to the basic ecology of any organism and can be influenced by a variety of environmental factors. Snakes are secretive and difficult to study, and environmental influences on movement are often obscure. The authors investigated drivers of terrestrial activity for 23 snake species from a temperate community in the Atlantic Coastal Plain region of South Carolina. Activity was strongly seasonal, with primarily fossorial species showing unimodal activity peaks in summer, whereas several aquatic species showed increased terrestrial movements to and from a wetland in both spring and fall. After controlling for seasonal activity, temperature and precipitation had consistent effects on snake movement, with activity of snakes increasing with temperature and decreasing with precipitation. The influence of moon illumination was more ambiguous but may have a weak, negative effect on snake activity. These environmental factors likely drive snake movements because of physiological constraints and trade-offs between foraging success and predation risk. These results contribute to general knowledge of snake natural history and ecology and may help improve sampling of these elusive organisms that are increasingly in need of conservation attention.

DEVELOPMENT OF MONITOR LIZARD EMBRYOS

R. M. Andrews et al. [2017, Journal of Herpetology 51(3): 396-401] note that *Varanus rosenbergi* females oviposit in nests excavated in termite mounds in summer, and hatching occurs the following spring after a 7-month incubation period. This study characterized developmental features associated with the prolonged incubation of this species at Kangaroo Island in South Australia. Oviposition occurs shortly after limb buds have formed, and the subsequent pattern of organogenesis is similar to that of other lizards. Survival of eggs incubated at constant temperatures ranging from 26–33°C was 89–100%, whereas survival at 24°C and at 35°C was 0 and 14%, respectively. During the incubation period, mean ambient temperature at Kangaroo Island (14–15°C) is too low for successful reproduction, whereas mean temperatures in termite mounds (27–37°C) are substantially warmer and similar to the estimated mean incubation temperature (26–27°C). Therefore, successful reproduction by *V. rosenbergi* in southern Australia may be contingent on nesting in termitaria. Varanids, in general, have incubation lengths that are substantially longer than those of most other squamates, turtles, and crocodilians. The authors hypothesize that varanids have prolonged incubation lengths primarily as an adaptation to maximize hatchling fitness because their emergence from nests in the warm and/or wet season of the year following oviposition is the time most favorable for growth and survival. Other factors that may contribute to prolonged incubation are the developmental costs of a large brain and the energy costs associated with nest locations and substrates that may make emergence difficult for hatchlings.

MULTIGENERATION FIELD EXPERIMENT ON *ANOLIS SAGREI*

T. W. Schoener et al. [2017, Copeia 105(3):543-549] report that only a handful of multi-generational experiments in natural systems of eco-evolutionary dynamics currently exist. To perform such a study, in 2008 the authors introduced the lizard *Leiocephalus carinatus*, a predator (and possible food competitor) of the lizard *Anolis sagrei*, to seven islands having *A. sagrei*, with seven unmanipulated islands having *A. sagrei* as controls. Almost immediately, *L. carinatus*, which is larger and more terrestrial than *A. sagrei*, caused a major habitat shift in *A. sagrei* away from the ground and toward higher and thinner perches; focal behavioral surveys showed that on islands where its predator was introduced, *A. sagrei* had less conspicuous visual displays. The expected pattern for density of *A. sagrei* is that it would decrease markedly at first via predation from the larger lizard, but then it would increase as the habitat shift selected for individuals better able to live in higher vegetation. Data through 2015 show this pattern, but a return to previous densities (time-by-treatment interaction) was not yet significant. A previous within-generation selection study and comparative data suggest that short legs should evolve as the lizards adapt to better maneuver on the thin perches of higher vegetation. However, no indication of the expected morphological change in limb length was present through 2015. Previous studies showed *A. sagrei* producing many effects on lower levels of the food web, some quite large. In this study through 2012, significant differences were found only in spiders (web and ground). A possible complication is that the study site was hit by two major hurricanes in the last five years, decreasing population sizes of both lizard species and reducing the experimental perturbations. A benefit of the hurricanes, however, is that they eliminated lizards from some islands, providing the opportunity to monitor natural recolonization, the frequency of which has eco-evolutionary implications. Surveys of the 44 islands that lost lizards showed that recolonization is rather slow. To explore long-term patterns of morphological variation, we monitored morphology of 31 island populations for up to 19 years. Mean limb length oscillated across the 19-year period, both increasing and decreasing substantially, yet the net effect over that period is almost no change. In years following hurricanes, limb length increases significantly more than expected by chance.

Advertisements

For sale: **highest quality frozen rodents**. I have been raising rodents for over 30 years and can supply you with the highest quality mice available in the U.S. These are always exceptionally clean and healthy with no urine odor or mixed in bedding. I feed these to my own reptile collection exclusively and so make sure they are the best available. All rodents are produced from my personal breeding colony and are fed exceptional high protein, low fat rodent diets; no dog food is ever used. Additionally, all mice are flash frozen and are separate in the bag, not frozen together. I also have ultra low shipping prices to most areas of the U.S. and can beat others shipping prices considerably. I specialize in the smaller mice sizes and currently have the following four sizes available: Small pink mice (1 day old—1 gm) , $25 /100; Large pink mice (4 to 5 days old—2 to 3 gm), $27.50 /100; Small fuzzy mice (7 to 8 days old—5 to 6 gm) , $30/100; Large fuzzy mice / hoppers (10 to 12 days old—8 to 10 gm), $35/100 Contact Kelly Haller at 785-234-3358 or by e-mail at kelhal56@hotmail.com

For sale or trade: Probable pair of albino Harquahala rosy boas. They were born in my home in late 2016 and are feeding on f/t peach fuzz mice. Pure locality animals exhibiting a recessive gene. Viewing is possible, parents on site. I can drive to meet a reasonable distance, or ship if you are not local. Discount if you pick them up from my home. Cash, credit card or PayPal. Call or text 510-318-1715, or email elenabmoss@gmail.com.

Herp tours: **Costa Rica herping adventures**. Join a small group of fellow herpers for 7 herp-filled days. We find all types of herps, mammals, birds and insects, but our target is snakes. We average 52 per trip, and this is our 10th year doing it. If you would like to enjoy finding herps in the wild and sleep in a bed at night with air-conditioning, hot water and only unpack your suitcase once, instead of daily, then this is the place to do it. Go to our web-site http:// hiss-n-things.com and read the highlights of our trips. Read the statistics of each trip and visit the link showing photos of the 40 different species we have found along the way. E-mail at jim.kavney@gmail.com or call Jim Kavney, 305-664-2881.

Line ads in this publication are run free for CHS members—$2 per line for nonmembers. Any ad may be refused at the discretion of the Editor. Submit ads to mdloogatch@chicagoherp.org.

NEW CHS MEMBERS THIS MONTH

Kyle Houlihan
Andy Swindler
John Egan
Robin Delapena
Jeremy Andersen
Christopher Weiss
Amelia and Jonathan Pollack
Christopher Akcali

UPCOMING MEETINGS

The next meeting of the Chicago Herpetological Society will be held at 7:30 P.M., Wednesday, November 29, at the Peggy Notebaert Nature Museum, Cannon Drive and Fullerton Parkway, in Chicago. This meeting will include the annual election of officers and members-at-large of the CHS Board of Directors. In addition, **David Mifsud**, co-author of the recently revised edition of *Amphibians and Reptiles of the Great Lakes Region*, will speak about "Tortoise Conservation in Madagascar."

The December 27 meeting will be a holiday party. The CHS will provide soft drinks and snacks. If you would like to bring something edible to share with the group, you are invited to do so. If you would like to bring an animal to show off to the group, you are encouraged to do that as well. This will be a chance to socialize all evening and get to know your fellow members a little better.

The regular monthly meetings of the Chicago Herpetological Society take place at Chicago's newest museum—the **Peggy Notebaert Nature Museum**. This beautiful building is at Fullerton Parkway and Cannon Drive, directly across Fullerton from the Lincoln Park Zoo. Meetings are held the last Wednesday of each month, from 7:30 P.M. through 9:30 P.M. Parking is free on Cannon Drive. A plethora of CTA buses stop nearby.

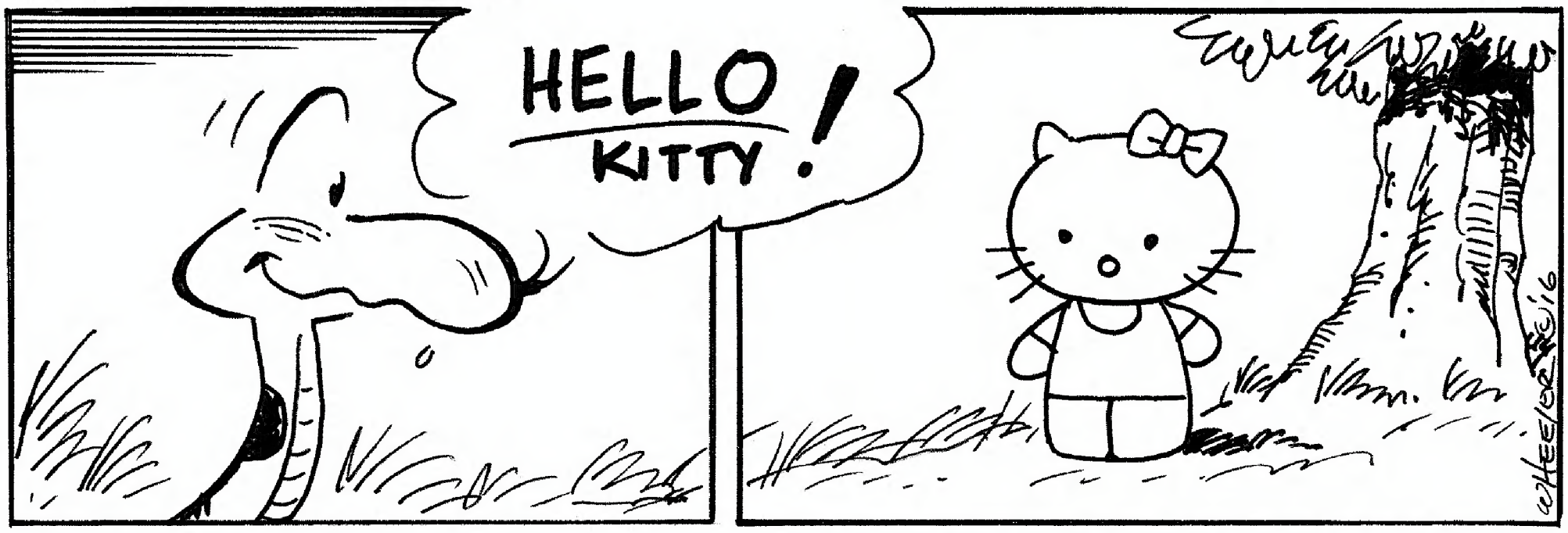
Board of Directors Meeting

Are you interested in how the decisions are made that determine how the Chicago Herpetological Society runs? And would you like to have input into those decisions? If so, mark your calendar for the next board meeting, to take place at 6:00 P.M., Saturday, December 16, 2017, at the home of Linda and Andy Malawy, 669 Chippewa Dr, Naperville..

The Chicago Turtle Club

The monthly meetings of the Chicago Turtle Club are informal; questions, children and animals are welcome. Meetings normally take place at the North Park Village Nature Center, 5801 N. Pulaski, in Chicago. Parking is free. For more info visit the group's Facebook page.

THE ADVENTURES OF SPOT



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